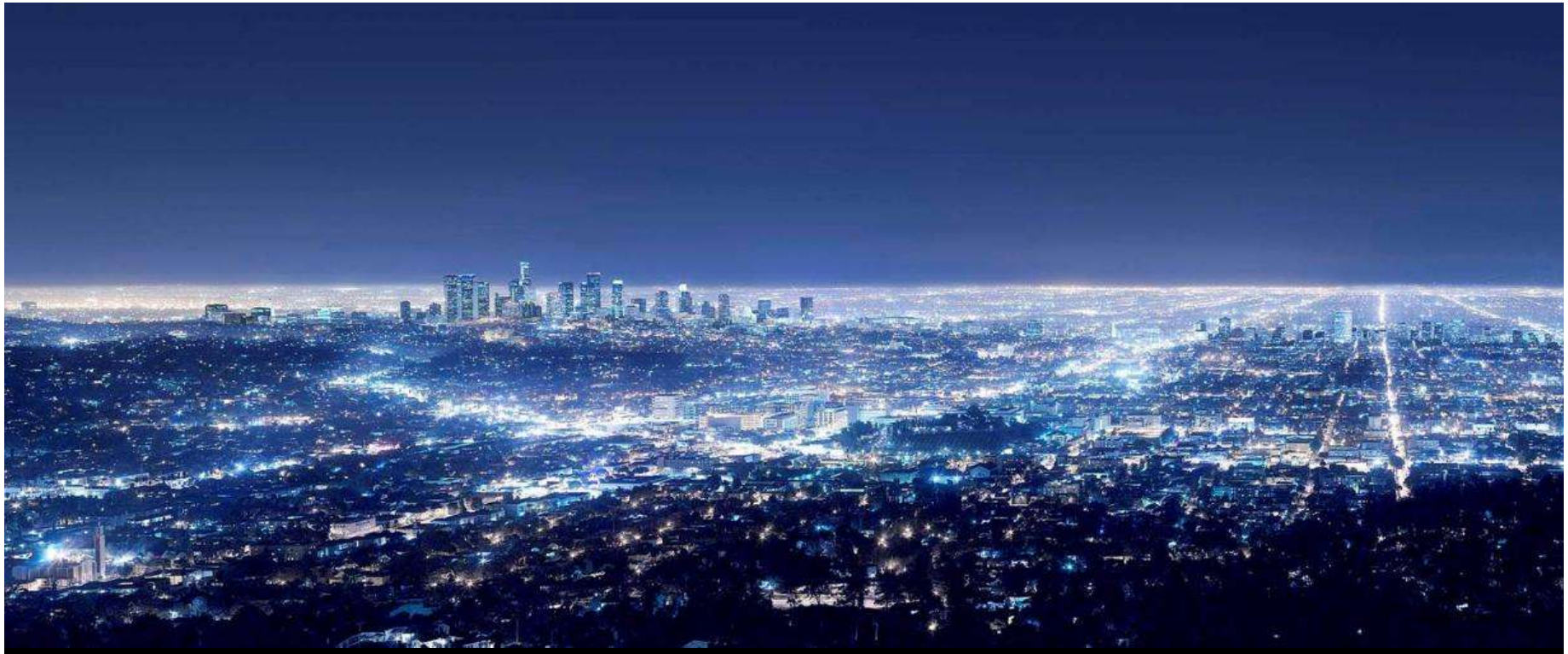
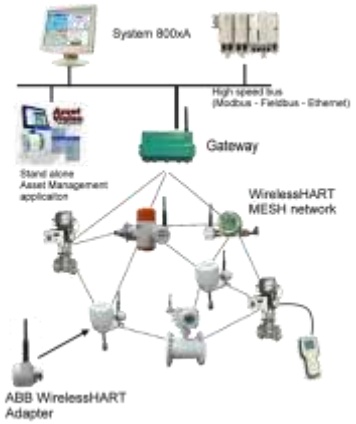


Stefan Svensson, Program Manager Industrial Communication ABB Corporate Research

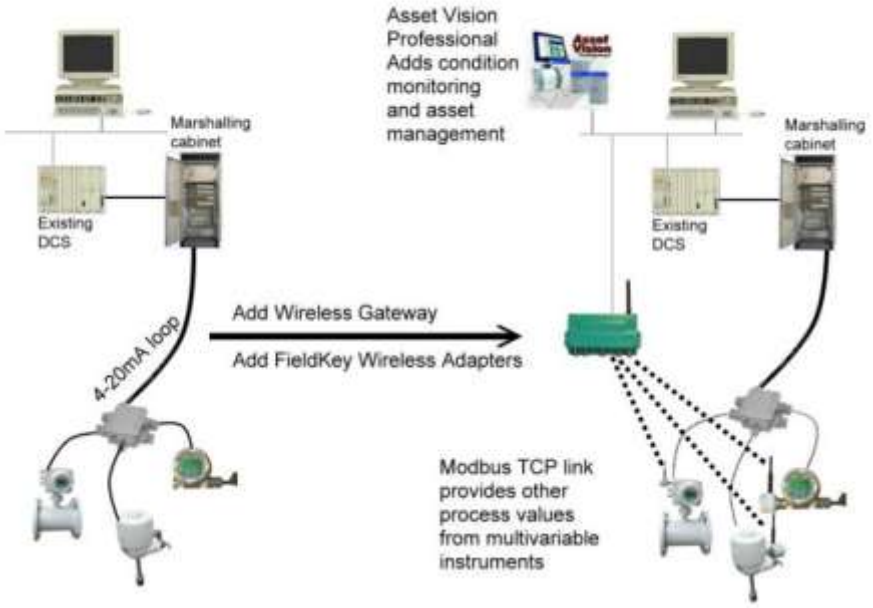
Challenges of Wireless Communication in Industrial Systems

Introduction to ABB wireless communication
Examples from ABB portfolio of wireless products



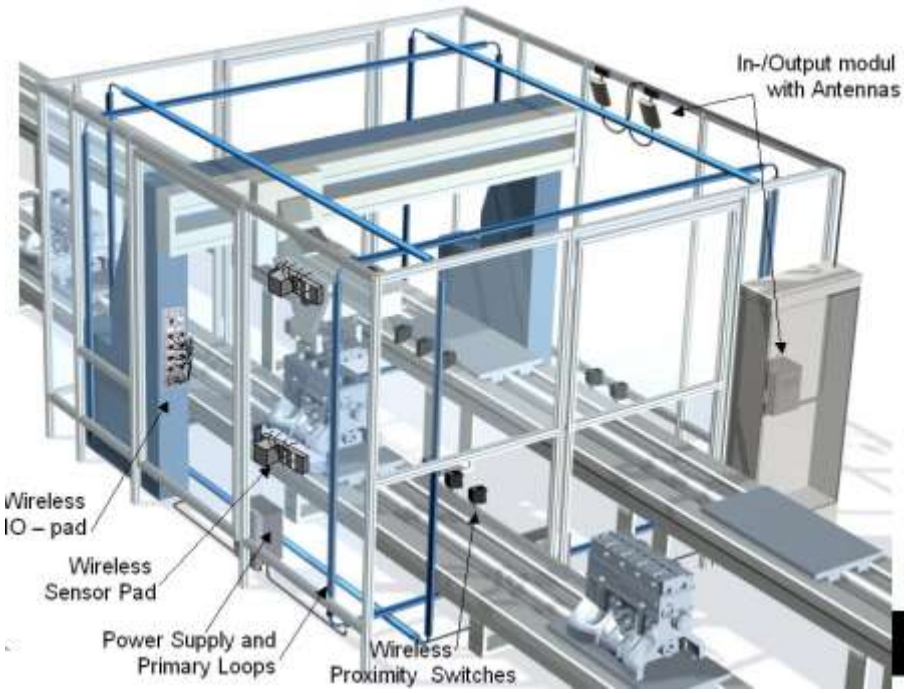
Introduction to ABB wireless communication
Fieldkey Wireless Adapters

- The WirelessHART standard was initiated in early 2004 and developed by ABB, Emerson and others.
- The underlying wireless technology is based on the TSMP technology from Dust Networks
- In April 2010, WirelessHart was approved by the IEC, making it the first international standard for wireless in process automation, IEC 62591
- WirelessHART, mainly addressing monitoring application (alerts & logging)



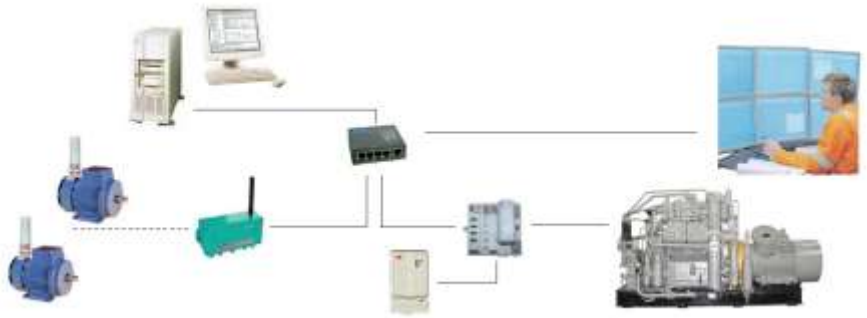
Introduction to ABB wireless communication
WISA / WSAN

- In ABB, the WISA concept (Wireless Interface to Sensors and Actuators) was created in 1998
- First WISA devices went into industrial production equipment in 2003 and the first series products were available in mid 2004.
- WISA-COM the tailor made wireless communication solution for factory automation based on IEEE 802.15.1 (physical layer) and WISA-POWER, the unique wireless power supply solution.
- Factory automation in many cases requires a response time of less than 10ms for a machine with more than 100 sensors and/or actuators.



Introduction to ABB wireless communication
WiMon

- Prototype developed in research project by ABB in cooperation with SKF and Sintef and with the support from several oil companies including StatoilHydro and BP in 2008.
- Product released in 2010
  - IP66
    Dust-tight and resistant to powerful water jetting
  - Hazardous area certification ATEX
    Zone 0, Ex ia IIC T4 -40.0C/+85.0C
  - Chemical environment
    ISA S71.04 1985 (Harsh)
- Using the WirelessHART standard for continuous communication



Industry challenges
Variation in application requirements

- Applications have different requirements
- No existing wireless radio system can satisfy all requirements simultaneously
- For WISA sensors communication module the typical air interface handling is 5 ms, with worst-case scenarios of up to 20 ms if the message must be re-transmitted several times.
- For WirelessHART the latency time in a typical installation is theoretically about 30 milliseconds (one hop) but in practice it can be about 2-3 seconds (optimized on energy consumption)

Table 2: Typical applications in factory and process automation: Time response requirements and telegram loss rates

Application area	Application	Max. transmission delay in ms	Update time in ms	Telegram loss rate or timeout*
Factory automation	Control** of machine and production cell „local"	10 .. 20	20 .. 30	$< 10^{-9}$
	Control in production hall „global"	20 .. 30	30 .. 100	$< 10^{-9}$
	Monitoring and diagnostics	> 100	> 500	10^{-3} - 10^{-9}
	Mobile operators, safety	10 .. 20	10 .. 30	$< 10^{-9}$
Process automation	Open-loop/ closed-loop control	50 .. 100	100 .. 5000	$< 10^{-4}$
	Operation „local"	> 100	< 1000	$< 10^{-3}$
	Monitoring and diagnostics	> 100	> 10000	$< 10^{-4}$

* For the user, the violation of the maximum transmission delay is equivalent to a frame loss since the information has become irrelevant, for example.
** Fast drive controls with time constants in the 1 ms range cannot be reliably covered by current wireless technologies.

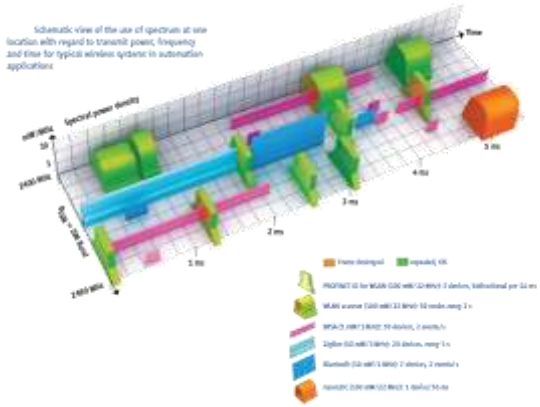
Industry challenges
Co-existence challenge

Coexistence is possible through decoupling in at least one of the sectors – location, frequency and time:

Spatial decoupling
- Adaptation of transmitted power
- Antenna selection
- Antenna positioning and orientation

Decoupling in the frequency domain
- Channel selection
- Blacklisting of frequency ranges or channels

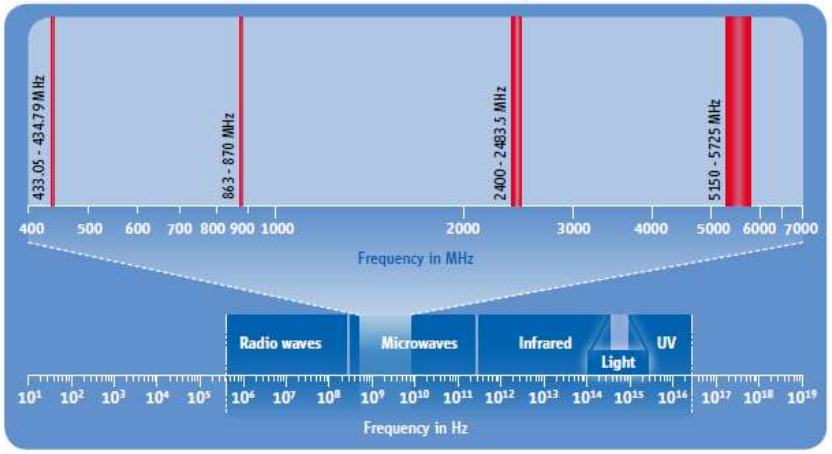
Minimization of frequency utilization over time
- Average loading of all individual systems as low as possible



- The same medium is used by all wireless systems for radio transmissions: the free air space which surrounds them
- Co-existence is defined as “The ability of one system to perform a task in a given shared environment where other systems have an ability to perform their task and may or may not be using the same set of rules.”

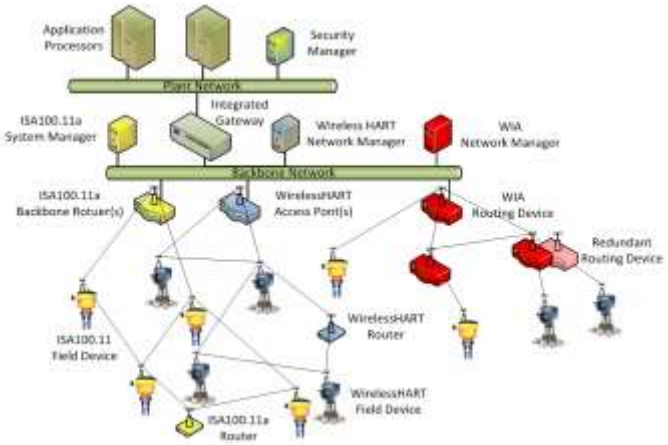
*Source: http://www.zvei.org/fileadmin/user_upload/Fachverbaende/Automation/Publikation/ZVEI_Coexistence_of_Wireless_Systems_in_Automation_Technology.pdf

Industry challenges
Regulations challenge



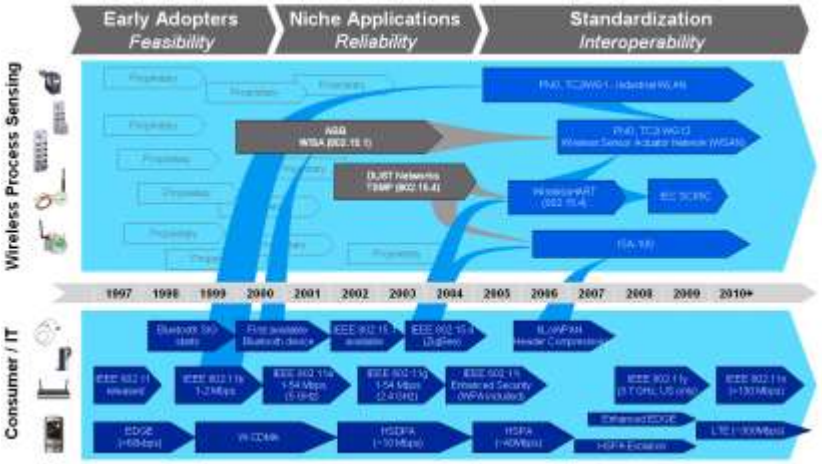
- The frequency utilization of short-range radio devices in the 2.4 GHz ISM band is regulated in EN 300 328, with the framework for presumption of conformity indicated in the R&TTE Directive
- ETSI, together with CENELEC, is responsible for the development of Harmonized Standards under the R&TTE Directive (1999/5/EC) in response to the EC mandates.
- New proposal restricts industrial usage in Europe

Industry challenges
Wireless convergence in Process Automation



- The reliability of wireless communication has already been proven in a wide variety of use cases, ranging from monitoring to safety critical applications
- The main obstacle for a rapid adoption of wireless technologies is no longer the lack of suitable technologies; rather it's the lack of lack of established industrial standards

Requirements on new technology
Wireless standards in Industry applications



- From proprietary solutions to standards, situation in wireless communication show similarities to what has happened with wired communication standards
- A global market place demands global solutions
- Faster adoption of consumer standards, IP based communication also in industry in near future?

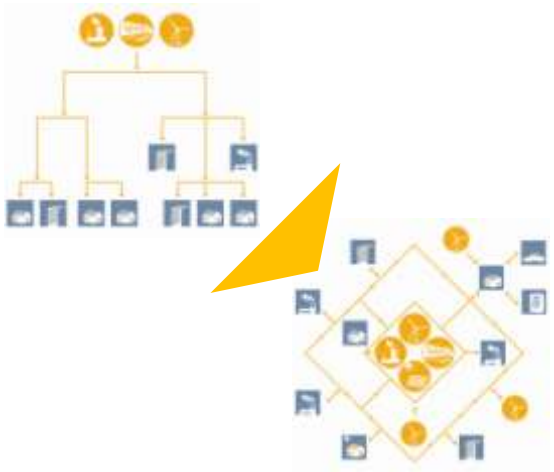
Requirements on new technology
Industry requirements differ from consumer

- In industry, uninterrupted production is first priority
- Plant managers will not adopt new technology until they are certain it can deliver real value to the operations
- One needs to resolve the key issues regarding technology, regulation, and cost

New challenges
Wireless in building automation applications

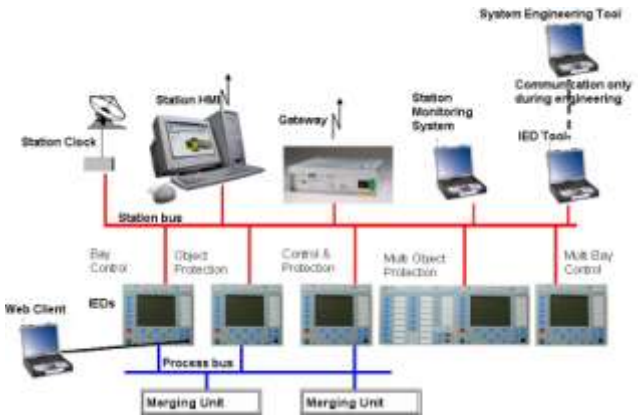
- Smart Homes and Building automation
- Demand & response mechanism to lower overall energy consumption
- KNX-RF communication for load management, not for media sharing or billing

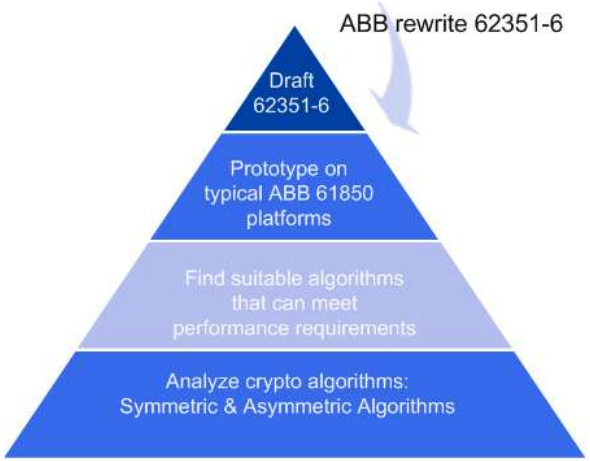
New challenges
Wireless in smart grid applications



- From traditional to smart grids with both centralized and distributed power generation
- Multi-directional power flow and operation based on real-time data
- Widely varying requirements depending on the application, heterogeneous communication technologies and few standards

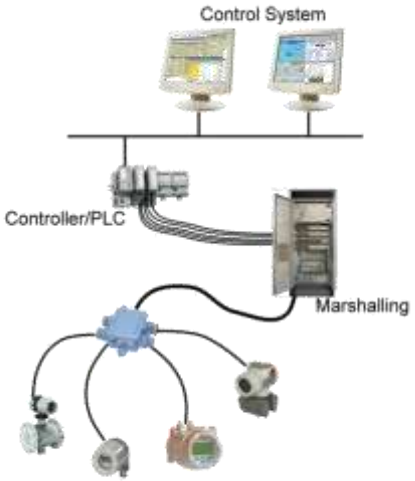
Technology challenges
Security – an example

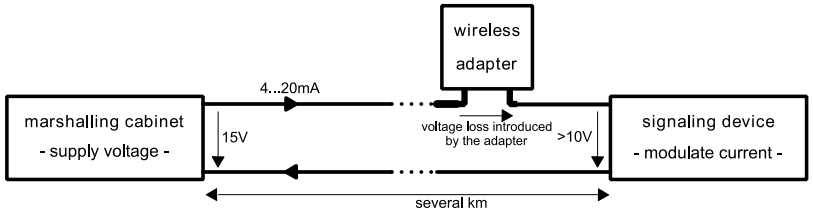




- Connectivity increase vulnerability independent if wired or wireless
- Real time requirements in resource constraint systems make PC based security solutions unsuitable
- ABB helped in re-writing of the IEC 62351 -6 security standard (RSA ~2 sec @ 200 MHz, AES GMAC ~3,84 ms @ 100 MHz)

Technology challenges
Low power – an example





- The power available to the adapter is given by the minimum loop current multiplied by the voltage loss created on the loop by the adapter. Since the voltage drop should be minimized the power is constrained
- The electronics were designed using an iterative approach to optimally distribute the power budget according to the different operation modes (stand-by, demodulation, modulation) and device structure (analogue, digital).

Outlook
Future trends

- Connect more than instruments; provide a wireless backbone for everything in the plant, localization capabilities increasing in importance
- Improved simulation to aid development
- Evaluate if and how standard technologies can be extended to support as much requirements as possible without rendering them inefficient

Summary

- Standardized solutions are often a requirement from ABBs customers but within the different application areas requirements are diverging, which means products may have to support more than one standard.
- Improvement of existing standards is important since missing functionality is continuously identified.
- Smart Grid initiatives have given rise to new standardization efforts for wireless communication
- Adding security mechanism to resource constraint devices is a challenge
- Miniaturization, regulations, communication and functional safety integration, HW-SW co-design & reliability continue to pose challenges to the research and development in this area

Power and productivity
for a better world™